of gravity in orbit offers the possibility of creating larger and purer crystals. But the more powerful beams coming from such new synchrotron sources as the Advanced Photon Source at the Department of Energy's Argonne National Laboratory outside Chicago are providing sharper pictures of these structures, making size less important. The role of microgravity in creating purer crystals is also ambiguous. Some 36 of 185 proteins and other biological macromolecular assemblies studied in space have shown higher resolution than the best results for those same materials on Earth, the panel notes, but it's not clear whether microgravity was the biggest factor contributing to those results.

Overall, the panel concludes that the impact of microgravity crystal work on structural biology "has been extremely limited." It urges NASA to fund competing work on Earth- and space-based crystals and to compare the results. If the results show no new breakthroughs from space-based projects, the panel warns, "then NASA should be prepared to terminate its protein crystal growth program."

Trinh says NASA will conduct such a competition and that the agency already intends to de-emphasize its former plans to grow crystals on a large scale. But he adds that the agency does not want to shut the door on potential commercial users of the station who might conduct crystal experiments. And Larry DeLucas, a crystallographer at the University of Alabama, Birmingham, says the past may not be a good guide to the future. He points out that the typical weeklong shuttle flight is often too short. "On the shuttle, 50% of our crystals grew too slowly" to be useful, he says. "The length of time is the real handicap," not the environment.

The panel also recommends that NASA reduce its emphasis on bioreactors, rotating vessels for growing cells aboard the station. The small amounts of data generated by the bioreactors, the difficulty in removing dead cells, and other technical issues could limit their usefulness, the panel members argue, and newer technologies, such as miniaturized culture systems and compact analytical devices, should be explored. But Trinh maintains that the bioreactors work well in the early stages of research.

Going beyond biotechnology, the panel also takes a swipe at NASA's practice of "borrowing" money from the pot allocated to new research facilities to pay for station construction. That trend, the panel members warn, will erode trust in the agency's user community, because "continual uncertainty is demoralizing and discouraging" and because researchers want to use the best facilities. If it continues, the report states bluntly, "NASA will send a clear message that science on the [space station] has a low priority and will alienate the research community even more."

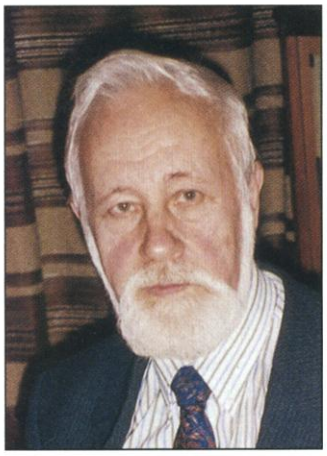
Another tough issue is how to undo the perception that NASA's biology program is a closed shop. Many of those involved in working groups or advisory committees "are ... the same people who make up the pool of grantees," the report notes. The panel urges the agency to expand its outreach efforts with the scientific community, and Trinh says NASA is doing just that. "We were really remiss," he says. "But once we open up our program to researchers in academia and industry, it will be easy to show that we are not parochial."

—ANDREW LAWLER

SCIENTIFIC COMMUNITY

Duo Dodges Bullets in Russian Roulette

One is in the twilight of his career, a physicist virtually unknown beyond Russia's borders. The other is an oceanographer in his prime, a rising star outside his native Ukraine. What these two have in common is a tribulation that once spelled death for a scientific career, if not for the accused himself: Each was charged with a serious crime by his country's security apparatus. Now the two share happier circumstances. Last month, both won victories suggesting that the judicial systems in the young democracies of Russia and Ukraine are not inclined to rubber-stamp trumped-up accusations against scientists.



KGB target. Physicist Vladimir Soyfer is hoping for exoneration.

CREDIT: R. STONE

In one case, 70-year-old Vladimir Soyfer of the Pacific Oceanological Institute in Vladivostok had been accused by the Federal Security Bureau (FSB), the successor to the KGB, of mishandling classified data. He won an initial court battle on 11 February, when a judge in Russia's Far East ruled that the FSB obtained the evidence on which the charges were based through an illegal search. The FSB has appealed the ruling, but if allowed to stand, it would cripple the FSB's case, observers say.

The second researcher, Sergey Piontkovski, 46, of the Institute of Biology of the Southern Seas in Sevastopol, Ukraine, got even better news. He was preparing to stand trial on charges of financial improprieties relating to his Western grant when, on 25 February, the local prosecutor dropped the charges soon after meeting with a delegation from the European agency whose grant was at the center of the controversy.

These victories, along with the recent acquittal of a Russian environmental activist, are huge morale boosters for former Soviet scientists, who have forcefully and publicly defended their colleagues. "It is a very important sign for me. I used to believe that the court is always on the KGB's side," says Valentina Markusova of the All-Russian Institute of Scientific and Technical Information in Moscow.

Before it dissolved in 1991, the Soviet Union was notorious for making its citizens pay for opposing its policies or getting too cozy with Western colleagues, and scientists were no exception. The constant was a presumption of guilt, until glasnost in the late 1980s laid the groundwork for the almost libertarian freedoms briefly enjoyed by Russians after the Soviet Union's dissolution. The pendulum soon swung back, however. In 1994, for example, Russia's security service charged a former chemical weapons researcher, Vil Mirzayanov, with revealing state secrets about a new class of nerve gas (*Science*, 25 February 1994, p. 1083). The arrest sparked an international outcry, and charges against Mirzayanov were subsequently dropped. Nevertheless, arrests of scientists and environmentalists have continued.

Among those seized was activist Aleksandr Nikitin. He was charged with espionage and divulging state secrets after co-authoring a report for Bellona, a Norwegian environmental group, on nuclear contamination from Russia's Northern Fleet. Last December, a judge in St. Petersburg acquitted Nikitin, a former nuclear safety inspector and retired Navy captain, and last month, the American Association for the Advancement of Science (which publishes *Science*) gave him, in absentia, its 1999 award for scientific freedom and responsibility. But Nikitin is not yet out of the woods. His case is on appeal, and he has not received his passport for foreign travel.

Only weeks ago, prospects were looking much bleaker for others who had been accused. Take Soyfer, whose nightmare began on 26 June 1999, when FSB agents raided his office, then descended on his home a week later. During the second raid they seized papers related to Soyfer's research on Chazhma Bay off Vladivostok, which was contaminated with radioactive materials after an accident involving a Soviet nuclear submarine in 1985. The work—sponsored by the Ministry of Atomic Energy and done in collaboration with the Radiochemical Safety Bureau of the Russian Navy, whose Pacific Fleet is based nearby—went well for 2 years, Soyfer says. But then, he claims, the safety bureau's new director took a disliking to him and called in FSB agents in Vladivostok to help oust him from the project. After seizing the research materials, the FSB charged Soyfer in early July with revealing secret information that "compromised the state and military security of the Russian Federation." Soyfer denied the charge, and colleagues rallied to his side.

Later that month, 11 top scientists and a deputy of the Duma, Russia's parliament, signed a letter to acting President Vladimir Putin, then prime minister, pointing out that the government had decreed earlier that ecological data could not be classified as state secrets. "We urgently request that you take measures to end the illegal persecution of V. N. Soyfer and other scientists," they wrote. Even more valuable to Soyfer's defense, an expert panel of the prestigious Kurchatov Institute in Moscow reviewed the disputed data and stated in a 7 February letter that none were secret. "The FSB does not have grounds for its attack," says Soyfer, who's waiting for the FSB to formally exonerate him in the wake of the court's ruling that the search was illegal.

Whereas Soyfer's cause was buoyed by his Russian colleagues, Piontkovski drew most of his support from scientists outside Ukraine. His saga began on 16 October, when agents from the Ukrainian Security Bureau (SBU) seized documents and cash from the homes and offices of Piontkovski and two colleagues (*Science*, 29 October 1999, p. 879). The focus of the search was Western grants that involved analyzing and digitizing data on bioluminescence collected over the past 30 years, first by Soviet and then by Ukrainian and Russian ocean expeditions.

After accusing the researchers of illegally passing data to the West, the SBU worked up charges against Piontkovski of illegal currency transfers: receiving and distributing funds under a grant from INTAS, a European agency that supports East-West scientific cooperation. Despite numerous appeals, the Ukrainian Academy of Sciences leadership failed to achieve any breakthroughs, but once the case was handed to the prosecutor, INTAS sprang to action.

INTAS chief David Gould and a legal adviser flew to Ukraine on 9 February, meeting with officials in Kiev and then with the prosecutor in Sevastopol. INTAS was ready to pull the plug on 55 new grants to Ukrainian teams if other scientists faced the threat of prosecution simply for cashing INTAS checks, Gould says. The prosecutor dropped the charges less than 2 weeks later. As *Science* went to press, Piontkovski was in Kiev, seeking a visa for an extended stay in the United Kingdom or the United States.

Now, observers are anxiously following the cases of three other former Soviet scientists whose fates remain up in the air. The FSB is still investigating Vladimir Tchurov, a colleague of Soyfer's at the Pacific Oceanological Institute, who is accused of selling sensitive acoustic technology to China, and last November it arrested Igor Sutyagin, an arms control researcher at the Russian Academy of Sciences' USA-Canada Institute in Moscow, on espionage charges.

Meanwhile, in Belarus—where democracy is struggling to take hold—Yuri Bandashevsky, an outspoken critic of the government's response to lingering health effects of the 1986 Chornobyl disaster, has been imprisoned since last July on charges of taking bribes. (His case has not been tried.) After the trio of recent judicial triumphs, the hope is that good news will again come in threes.

–RICHARD STONE

GEOMICROBIOLOGY

Hardy Microbe Thrives at pH 0

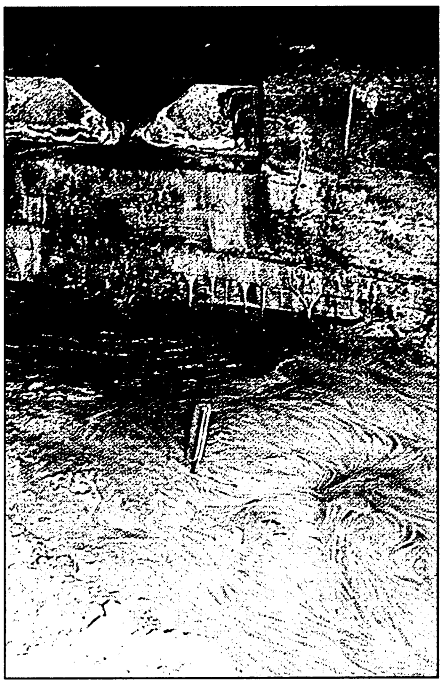
This one is extreme, even for an "extremophile." While surveying the depths of an abandoned copper mine, a team of geomicrobiologists has detected a new microbe that survives in some of the most acidic waters on Earth, at a seemingly impossible pH near 0. That makes this critter, a member of the microbial kingdom Archaea, one of a few record-setting bugs that can survive in conditions usually toxic to life as we know it.

Not only does this microbe, dubbed *Ferroplasma acidarmanus*, survive, but it positively thrives. Indeed, it accounts for the overwhelming majority of life-forms found at the inhospitable mine, report Katrina Edwards of the Woods Hole Oceanographic Institution in Massachusetts and her colleagues on page 1796. And that, in itself, is "remarkable," says microbiologist John Baross of the University of Washington, Seattle. Most extreme environments studied so far—whether hot, frigid, acid, alkaline, or high pressure—support a diversity of life, usually a collection of hardy bacteria, notes Baross. But at the Iron Mountain mine near Redding, California, just this one microbe rules.

The bug's hardiness is even more surprising considering its architecture. Most microorganisms have cell walls to shield them from harsh surroundings, but not these Archaea. They are encased in what appears to be just a simple cell membrane—a seemingly flimsy way to guard against sulfuric acid and the high amounts of copper, arsenic, cadmium, and zinc also present in the drainage. Yet that membrane "seems totally capable of maintaining them in environments that would destroy most other organisms," marvels William Ghiorse, a geomicrobiologist at Cornell University. Moreover, because this microbe can't survive in water of a normal pH, "the high acidity seems to be essential to maintain the membrane." The researchers are trying to figure out how this membrane works.

Edwards helped track down *F. acidarmanus* while she was a graduate student working with Jillian Banfield, a mineralogist at the University of Wisconsin, Madison. They were trying to understand the role of microorganisms in the geochemical processing of sulfur and the generation of acid mine drainage. Earlier Banfield and Edwards had sampled water from 500 meters inside the same mine, using molecular probes designed to recognize genetic material specific to different types of organisms. At the time, they found no signs of the bacteria that are often cultured from mine drainage water (*Science*, 6 March 1998, p. 1519). But the probes did detect large populations of Archaea—microbes typically associated with other types of extreme environments, such as hot springs.

Over the past 2 years, the team periodically resampled the mine's waters and from them has isolated and grown the one species that is predominant: *F. acidarmanus*, which grows best at a pH of 1.2 but can grow in a range from pH 0 to 2.5. Most other organisms recovered from acid mine drainage grow best at a pH of 2.5 and survive anywhere from a pH of 1 to 4. Other re-



Dark secrets. Deep in a mine, strands of acid-loving microbes make water ever more acidic.

CREDIT: B. GOEBEL